

STUDY GUIDE

SURFACE WATER

SUBCLASS S

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PREFACE

This operator's study guide represents the results of an ambitious project. Operators of water supply facilities, regulators, educators and local officials, jointly prepared the objectives and exam questions for the Water Supply Surface Water Certification Exam.

The objectives in this study guide have been organized into four modules: (A) Principle, Structure and Function; (B) Operation and Maintenance; (C) Monitoring and Troubleshooting; and, (D) Safety And Calculations. The objectives are organized to correspond to the major concepts in each module.

This study guide was revised in 2006 to include new objectives relating to the EPA Disinfectants and Disinfection Byproducts (D/DBP) Rule. Objectives that were newly developed or revised to cover the D/DBP Rule are preceded by "***NEW***". Exam questions have been written to correspond to the concepts included in this study guide.

HOW TO USE THESE OBJECTIVES WITH REFERENCES

In preparation for the Water Supply Surface Water Exam, the operator should:

1. Read all the objectives and write down the answers to the objectives that readily come to mind.
2. Use the resources at the end of the objectives to look-up those answers you are not sure of.
3. Write down the answers found in the resources to those objectives you could not answer from memory.
4. Review all answered objectives until you can answer each from memory.

IT IS ADVISABLE THAT THE OPERATOR ATTEND SOME FORM OF FORMAL TRAINING IN THIS PROCESS BEFORE ATTEMPTING THE CERTIFICATION EXAM.

Choosing A Test Date

Before you choose a test date, consider the training opportunities available in your area. A listing of training opportunities and exam dates can be found in the annual DNR "Certified Operator," in the DNR's Operator Certification & Licensing Training Calendar on the DNR Web Site (<http://www.dnr.state.wi.us/org/es/science/opcert/training.htm>) or by contacting your DNR District operator certification coordinator.

SURFACE WATER

MODULE A: PRINCIPLE, STRUCTURE AND FUNCTION

CONCEPT: PRINCIPLES OF SURFACE WATER TREATMENT

1. Define an Ion, Anion, and a Cation.
2. Define surface water and give examples of the various forms.
3. Define the term Watershed.
4. Describe the movement of water through the Hydrologic Cycle.
5. Discuss Lake Turnover and its affect on surface water quality.
6. Explain the circulation and stagnation zones of surface waters and reservoirs.
7. List the factors controlling runoff volume/rates.
8. Describe the term surface water potability.
9. List various types of unwanted chemicals found in surface water and sources of the contamination.
10. List various harmful waterborne microbiological organisms and the diseases they cause.
11. Define the following terms associated with surface water treatment:
 - A. Raw Water.
 - B. Colloidal.
 - C. Sedimentation.
 - D. Sludge Blanket.
 - E. Turbidity.
 - F. Finished Water.
 - G. Sludge.
12. Describe the characteristics of primary and secondary drinking water standards.

13. Define the differences between the following:
- A. An Exemption.
 - B. A Conditional Waiver.
 - C. A Compliance Agreement.
14. ****NEW**** Explain why the disinfection by-products trihalomethanes (TTHMs) and haloacetic acids (HAA5s) are a problem in drinking water.
15. ****NEW**** Describe how trihalomethanes (TTHMs) and haloacetic acids (HAA5s) are formed.

CONCEPT: STRUCTURE AND FUNCTION

16. Explain how submerged lights placed at the outlet of a mixing basin can aid the operator.
17. List the controls and gauges which should be on a typical filter console.
18. Describe the following valves used in water treatment plants.
- A. Gate Valve.
 - B. Butterfly Valve.
 - C. Check Valve.
 - D. Ball Valve.
 - E. Globe Valve.
 - F. Plug Valve.
 - G. Pressure Regulating Valve.
19. Explain how a Reduced Pressure Principal Backflow Preventer is used at a Water Treatment Plant.
20. List the most common types of positive displacement pumps and explain how they work.
21. List the most common types of centrifugal pumps.

22. Discuss how a centrifugal pump works and the function of the following components:
- A. Impeller.
 - B. Shaft.
 - C. Shaft Sleeve.
 - D. Bearings.
 - E. Lantern Ring.
 - F. Mechanical Seal.
 - G. Pump Casing.
 - H. Packing Gland.
23. Describe gravimetric and volumetric chemical feeders.
24. Describe the operation and following components of a solution-feed vacuum-type gas chlorination system.
- A. Chlorine Gas Cylinder.
 - B. Yoke Unit.
 - C. Control Unit (Chlorinator).
 - D. Gas Vacuum Line.
 - E. Booster Pump and Piping.
 - F. Ejector.
 - G. Exhaust Fan.
25. List two types and applications of filtration in use at water treatment plants, and identify some materials used for filter media.

MODULE B: OPERATION AND MAINTENANCE

CONCEPT: OPERATION

26. ****NEW**** Explain how to predict disinfection by-product formation and list the appropriate analytical methods.
27. Discuss why fluoridation is practiced, and identify common fluoride compounds used in surface water treatment.

28. List the function of the following chemicals used at surface water facilities:
- A. Carbon.
 - B. Chlorine.
 - C. Potassium Permanganate.
 - D. Alum.
 - E. Ferric Chloride.
 - F. Polymers.
 - G. Hydrofluosilicic Acid.
 - H. Activated Silica.
 - I. Lime.
 - J. Phosphates.
 - K. Caustic Soda.
 - L. Ozone.
29. Describe the metal commonly used as an expendable auxiliary anode for corrosion control in steel tanks.
30. Identify the following terms used to express concentrations.
- A. ppm.
 - B. lbs/mg.
 - C. mg/L.
 - D. ug/l.
 - E. ppb.
31. Explain Total Dynamic Head.
32. Define pretreatment, and list the common processes in surface water pretreatment.
33. Explain what changes need to be performed to control the affects of lake turnover on surface water quality.
34. Define T10 and how it is determined.
35. Explain post-chlorination, and why it is done.
36. Explain the process of chemical disinfection for the following:
- A. To The Water Supply.
 - B. To The Tanks and Pipes.
37. Explain the various forms of chlorine used for water disinfection.

38. List the disinfectants available for cyst and virus inactivation.
39. Discuss the following terms related to chlorination:
 - A. Chlorine Demand.
 - B. Free Chlorine.
 - C. Combined Chlorine.
 - D. Total Chlorine Residual.
 - E. Gas (Chlorine).
 - F. Solid (Calcium Hypochlorite).
 - G. Liquid (Sodium Hypochlorite).
40. Sketch a flow diagram of a surface water treatment plant identifying the major processes.
41. Explain how the chlorine cylinder is connected to the chlorine feed equipment.
42. Describe coagulation and flocculation.
43. List the common chemical coagulants used in surface water treatment.
44. Discuss the use of coagulant aids, and identify several types.
45. Describe how the following may affect coagulation:
 - A. Temperature.
 - B. pH.
 - C. Concentration of Dissolved Solids.
 - D. Concentration of Suspended Solids.
 - E. Mixing Conditions.
 - F. Concentration of Coagulant.
46. ****NEW**** Describe enhanced coagulation and how it reduces disinfection by-product precursor levels.
47. Describe flocculation basins.
48. Describe rate-of-flow controllers.
49. Explain the limiting factors which govern the rate-of-flow in a filter.

50. Identify typical design rates for filtering and backwashing in gpm/square feet for the following filters:
 - A. Rapid Sand Filter.
 - B. Dual Media (Coal/Sand) Filter.
 - C. Multi-Media (Coal/Sand/Garnet) Filter.
51. Discuss the gel-like material (Schmutzdecke) commonly found on filter surfaces.
52. Identify factors determining when filter media should be replaced.
53. Identify the factors which indicate the need and duration for backwashing.
54. Describe the steps in backwashing a filter.
55. Indicate the Valve Position (Open or Closed) for the following operational valves during both Filtering and Backwashing.
 - A. Influent Valve.
 - B. Effluent Valve.
 - C. Washwater Valve.
 - D. Surface Wash Valve.
 - E. Waste or Drain Valve.
 - F. Backwash Valve.
56. Explain the operation and maintenance of sedimentation basins.
57. Discuss suitable means of sludge disposal.
58. ****NEW**** Identify control strategies for trihalomethanes (TTHMs) and haloacetic acids (HAA5s) acids.
59. ****NEW**** Discuss disinfection by-product precursors, precursor sources, and how to control them.
60. ****NEW**** Describe treatment process modifications capable of controlling trihalomethanes (TTHMs) and haloacetic acids (HAA5s) acids.
61. ****NEW**** Describe the disinfection by-product bromate, its precursor, how it forms, and how it can be controlled.

CONCEPT: MAINTENANCE

- 62. Describe the maintenance of a positive displacement pump.
- 63. Describe the maintenance of a centrifugal pump with regard to the following:
 - A. Priming.
 - B. Packing.
 - C. Bearings.
 - D. Alignment.
- 64. Describe problems associated with pump packing.
- 65. Explain the importance of a surface wash in the filter cleaning process.

MODULE C: MONITORING AND TROUBLESHOOTING

CONCEPT: MONITORING

- 66. Describe the Maximum Contaminant Level (MCL) for bacteria in surface water.
- 67. List the Maximum Contaminant Levels (MCL) or Performance Standards for the following:
 - A. Fluoride.
 - B. Nitrate.
 - C. Total Trihalomethanes (TTHM).
 - D. Turbidity.
- 68. List the monitoring requirements for the following:
 - A. Inorganic Chemicals.
 - B. Nitrate.
 - C. Lead and Copper.
 - D. Organic Chemicals.
 - E. Turbidity.
- 69. Describe the bacteriological monitoring requirements for surface water suppliers.
- 70. Define CT Value and list the variables needed to determine a required Ct Value.

71. List the total inactivation/removal for Giardia Lambia Cysts and and Viruses required by the EPA Surface Water Treatment Rule.
72. List the removal credit given for a well operated conventional plant and resultant disinfection levels required.
73. Explain the sampling locations in the water supply system for the following:
 - A. Inorganic Chemicals.
 - B. Corrosivity.
 - C. Organic Chemicals.
74. Discuss the procedure an operator must follow when dealing with an "unsafe" bacteriological sample.
75. List the circumstances where public notification is required.
76. Define minimum chlorination residuals.
77. Explain the frequency of testing disinfectant residual in a water distribution system.
78. **NEW** Explain the term maximum residual disinfectant level (MRDL) and list the MRDL for chlorine, chloramines and ozone.
79. Explain the preparation of a bacteriological sampling bottle for testing for chlorination.
80. Discuss the acceptable range, and optimum levels for fluoridation.
81. Explain the preparation procedure for bottles used to collect fluoride samples.
82. Discuss monthly fluoride split samples, and what to do with them.
83. Explain the frequency of testing for fluoride in a water distribution system.
84. Identify common laboratory tests for fluoride, and the procedures used to perform the test.

85. Describe the Jar Test and it's function.
86. Define the following terms:
- A. End Point.
 - B. Acidic.
 - C. Basic.
 - D. NTU.
87. State how many buffers should be used when calibrating a pH meter.
88. Explain the suitable buffers used for Basic and Acidic samples.
89. Explain how to read a water level meniscus.
90. Describe a colorimetric analysis, and list which tests are commonly performed by this method.
91. Describe the following total chloride residual tests:
- A. DPD Colorimetric.
 - B. DPD Titrimetric.
 - C. Amperometric Titrimetric.
92. Describe a Specific Ion Probe, and list example tests that use this method.
93. Identify the tests used to establish corrosive and deposition potential of finished water.
94. Discuss the primary chemical parameters used to determine coagulation, disinfection, softening and corrosion control.
95. List the steps in using the following to perform a Bacteria Analysis:
- A. Using a Membrane Filter.
 - B. Using the Multiple Tube Fermentation Method.
 - C. Using the Standard Plate Count.
 - D. Using Colilert.
96. ****NEW**** Identify where samples are collected for trihalomethanes (TTHMs) and haloacetic acids (HAA5s) analysis and list the MCLs.

CONCEPT: TROUBLESHOOTING

97. Discuss the importance, types, and operational concerns with the necessity for standby power.
98. List common pump problems and their possible cause.
99. Discuss how a sand detector might be of value in relation to filtration.
100. Discuss "negative head" and how it affects water filtration.
101. Explain how media size effects headloss and filter run.

MODULE D: SAFETY AND CALCULATIONS

CONCEPT: SAFETY

102. Identify the possible hazardous areas or situations that may be present at a surface water facility.
103. Describe proper safety procedures and/or equipment used in the following:
 - A. Confined Spaces.
 - B. Moving or Rotating Equipment.
 - C. Condensation on Floors.
 - D. Laboratory.
 - E. Stairs.
 - F. Chlorine/Fluoride Handling.
 - G. Degradation of Metal.
 - H. Low Piping.
 - I. Electrical Equipment.
104. Discuss typical chemical feed room safety equipment needed for the following common surface water treatment chemicals.
 - A. Chlorine Gas.
 - B. Alum/Fluoride.
 - C. Carbon.
 - D. Lime.
105. Describe protective measures used to store and handle water treatment chemicals.

106. Identify various types of respiratory protection devices.

107. Describe a method of detecting chlorine gas leaks.

CONCEPT: CALCULATIONS

108. Explain how to calculate theoretical hydraulic detention time in rectangular and circular sedimentation basins and reservoirs.

109. Explain how to calculate the backwash flow rate.

110. Explain how to calculate the percent of total water production used for backwashing.

111. Explain how to calculate chlorine feed rate.

112. Explain how to calculate Filtration Rate in gallons per minute per square foot.

113. Explain how to calculate the pounds per gallon of a given solution if the specific gravity is known, or how to calculate the specific gravity if the weight per gallon is known.

114. Explain the dosage calculations necessary if powdered activated carbon is utilized for odor control.

115. Calculate the pounds of alum required per day, based on desired concentration, a given flow rate and the percent alum available.

116. Determine the amount of a concentrated solution required to achieve a diluted concentration in a larger volume.

SURFACE WATER RESOURCES

1. Kawamura, Susumu, INTEGRATION DESIGN OF WATER TREATMENT FACILITIES. John Wiley & Sons, Inc., New York, New York, (1991).
2. GUIDANCE MANUAL FOR COMPLIANCE WITH THE FILTRATION AND DISINFECTION REQUIREMENTS FOR PUBLIC WATER SYSTEMS USING SURFACE WATER SOURCES. US EPA, AWWA, (1991)
3. MUNICIPAL WATER SUPPLIES: MUNICIPAL OFFICIALS REFERENCE GUIDE. Wisconsin Department of Natural Resources, Bureau of Drinking Water and Groundwater, PUBL-WS-010-86, 1986. (May be obtained from Local DNR District)
4. CROSS CONNECTION CONTROL MANUAL. Wisconsin Department of Workforce Development(Formally DILHR), P.O.Box 7969, Madison, WI, 53707.(1994)
5. STANDARD METHODS FOR THE EXAMINATION OF WATER AND WASTEWATER. 17th Edition (1989), 18th Edition (1992). Joint Publication of: American Public Health Association; American Water Works Association;and, Water Environment Federation (Old WPCF). Publication Office: American Public Health Association, 1015 Fifteenth Street NW, Washington, DC 20005.
6. WATER TREATMENT PLANT OPERATION. 2nd Edition (1989). Volumes 1 and 2. Kenneth D. Kerri. California State University, 6000 J Street, Sacramento, CA 95819-6025. Phone (916) 278-6142.
7. WISCONSIN ADMINISTRATIVE CODE NR 809 SAFE DRINKING WATER. Wisconsin Revisor of Statutes Bureau.
8. WISCONSIN ADMINISTRATIVE CODE NR 811 REQUIREMENTS FOR THE OPERATION AND DESIGN OF COMMUNITY WATER SYSTEMS. Wisconsin Revisor of Statutes Bureau.

Wisconsin Administrative Codes are available electronically at <http://www.legis.state.wi.us/rsb/code.htm>. To purchase printed code books contact the Wisconsin Department of Administration, Document Sales and Distribution Section at 608-266-3358.

9. ****NEW** Complying With the Stage 1 Disinfectants and Disinfection Byproducts Rule: Basic Guide.** US EPA (March 2006) EPA No. 816-B-05-004.

Supplement A to the above publication covers water systems that use chlorine dioxide or ozone as a disinfectant. US EPA (March 2006) EPA No. 816-B-05-005.

Supplement B to the above publication covers water systems that utilize a surface water source. US EPA (March 2006) EPA No. 816-B-05-006.

EPA publications can be downloaded from EPA's Safe Drinking Water Web site at www.epa.gov/safewater (search by publication number). You can also call the Safe Drinking Water Hotline at 1-800-426-4791 to request the documents.

THE FOLLOWING ADDITIONAL RESOURCES CAN BE OBTAINED FROM:

AMERICAN WATER WORKS ASSOCIATION
MEMBER SERVICE DEPARTMENT
6666 W. QUINCY AVENUE
DENVER, CO 80235
(303) 794-7711
1-800-92-ORDER

(THE TOLL FREE NUMBER IS FOR CHARGE CARD CUSTOMERS OR AWWA MEMBERS)

10. **CORROSION CONTROL FOR OPERATORS.** AWWA No. 20232 (1986).
11. **CROSS-CONNECTION AND BACKFLOW PREVENTION.** Gustave J. Angele. AWWA No. 20106 (1974).
12. **DISINFECTION BY-PRODUCTS: CURRENT PERSPECTIVES.** AWWA No. 20032 (1989).
13. **FILTRATION STRATEGIES TO MEET THE SURFACE WATER TREATMENT RULE.** Raymond D. Letterman. AWWA No. 20268 (1991).
14. **MAINTENANCE MANAGEMENT.** James K. Jordan. AWWA No. 20252 (1990).
15. **NEW DIMENSIONS IN SAFE DRINKING WATER-SECOND EDITION.** AWWA No. 20235 (1988).
16. **PLAIN TALK ABOUT DRINKING WATER.** James M. Symons. AWWA No. 70076 (1991).
17. **PUBLIC INFORMATION - HOW TO BUILD A SUCCESSFUL PUBLIC INFORMATION/PUBLIC RELATIONS PROGRAM.** AWWA No. 20242 (1989).

18. **SAFE DRINKING WATER ACT SERIES:**
SURFACE WATER TREATMENT RULE. AWWA No. 70055 (1990)
PUBLIC NOTIFICATION. AWWA No. 70056 (1990)
TOTAL COLIFORM RULE. AWWA No. 70057 (1990)
VOC'S AND UNREGULATED CONTAMINANTS. AWWA No. 70058 (1990)
LEAD AND COPPER. AWWA No. 70073 (1991)
PHASE II: VOC'S, IOC'S, AND SOC'S. AWWA No. 70074 (1991)
19. **SLUDGE: HANDLING AND DISPOSAL.** AWWA No. 20034 (1989)
20. **SURFACE WATER TREATMENT: THE NEW RULES.** Harry Von Huben. AWWA No. 20249 (1991)
21. **TREATMENT TECHNIQUES FOR CONTROLLING TRIHALOMETHANE IN DRINKING WATER.** AWWA, No. 20221 (1982).
22. **WATER CONSERVATION.** William O. Maddaus. AWWA No. 20238 (1987)
23. **WATER QUALITY AND TREATMENT-FOURTH EDITION.** AWWA No. 10053 (1990).

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